The System Engineering Challenges of Implementing an Automatic Wire Analyzer (AWA) System for the Naval Aviation Community

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Agenda

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  - NAVAIR Goals
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- NAVAIR addressing the Challenges
- AWA System Implementation
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- Final Thoughts

Background

- Until recently wiring was not considered a maintenance requirement
  - No periodic maintenance procedures existed that directly addressed wiring
  - Very little data existed on the failure or repair of wiring
  - Few tools existed for maintainers to troubleshoot wiring

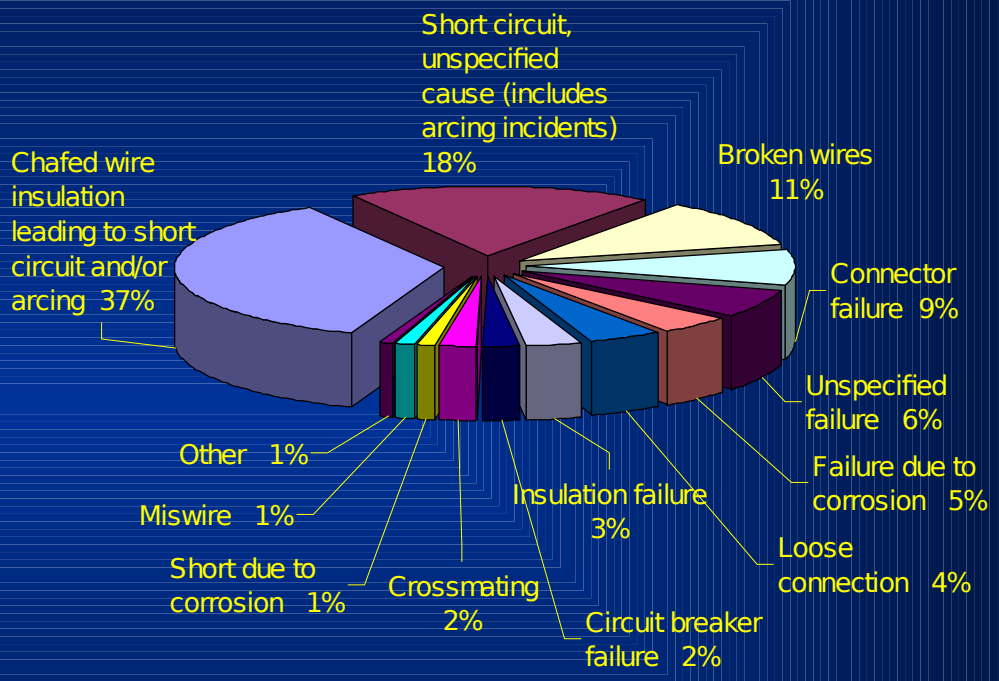
Background

- Why should we care about wiring on U.S. Navy aircraft?
  - 30 months of fleet data shows us
    - 2.5 electrical fires/month
    - 2 aircraft lost due to electrical fires
    - Averaging 1,400 mission aborts/year (540 in-flight aborts/year)
    - 1-2 Million operational man-hours/year spent troubleshooting/repairing wire problems
    - Averaging 120+ Non-Mission Capable aircraft/year
  - Wiring is the number 2 safety concern of the fleet (Source 2002 Avionics OAG)

Metrics and Wire Failure Modes

Quarterly Metrics

- Inventory
- Flight Hours
- Readiness (NMC)
- Availability (Aborts)
- Safety (Mishaps)
- Reliability (MTBF)
- Maintainability (MMH)
- Supportability (MFHBCC)
- O&S Costs (M&S Costs)


Short circuit, unspecified cause (includes arcing incidents) 18%
Broken wires 11%
Chafed wire insulation leading to short circuit and/or arcing 37%
Connector failure 9%
Unspecified failure 6%
Failure due to corrosion 5%
Loose connection 4%
Insulation failure 3%
Circuit breaker failure 2%
Crossmating 2%
Short due to corrosion 1%
Miswire 1%
Other 1%

fectively 125 Non Mission Capable Aircraft/Year Due to Wir

CTTO AWA Program

- NAVAIR Goals
  - Research, Development, Test and Evaluation of technology for the localization of hard faults and degenerative conditions
    - Hard faults: opens and shorts
    - Degenerative conditions: chafing, cracks, material decomposition, corrosion, water intrusion
    - Branching circuits
  - Commercial technology adaptation for military applications
    - User interface and maintenance database interface
    - Open system architecture
    - Specification development for out-year procurements

CTTO AWA Program

- Program Objectives
  - Improve the Navy's ability to test and troubleshoot aircraft wiring systems at all maintenance levels.
  - Reduce operational and logistical costs associated with wiring malfunctions.
  - Identify and document maintenance requirements necessary to meet the first two objectives.
  - Evaluate AWA Technology primarily for use at the Depot level, to include IMC applications
  - Investigate for use at Intermediate maintenance levels.

CTTO Program

- Program Objectives
  - Mature the AWA technology and associated ILS to evolve the AWA into a viable solution for fleet testing, troubleshooting and prognostication of aircraft wiring systems.
  - Through coordination with all participating commands, formulate an effective acquisition strategy to procure AWA technology equipment

System Engineering Challenges

- Defining the Requirements
  - The Needs of O,I and D level maintenance vary greatly, defining a system that benefits all with minimum compromise is difficult
  - Process and procedure differences exist between the depots on reporting and data collection
  - Data on wiring maintenance is often reported at a subsystem level and detailed particulars are often lost

System Engineering Challenges

- Designing the System
  - State of the Technology
    - Technology to Detect Hard faults continues to improve
    - Technology to locate Hard fault is improving
    - Technology to detect degenerative conditions is limited
    - Technology to locate degenerative conditions is in its infancy
    - No one technology or tool is the silver bullet to cure all

System Engineering Challenges

- Fielding the System and Support
  - Maintenance procedures for the inspection of wiring is primarily visual at the various levels of maintenance
  - At O and I Levels of maintenance; problems are isolated to black boxes (remove and replace); rarely to wiring unless there is visible damage
  - Approximately $94 Million spent on no-fault found equipment removals due to undiagnosed wiring problems
  - Wiring is not viewed as the problem until all else fails

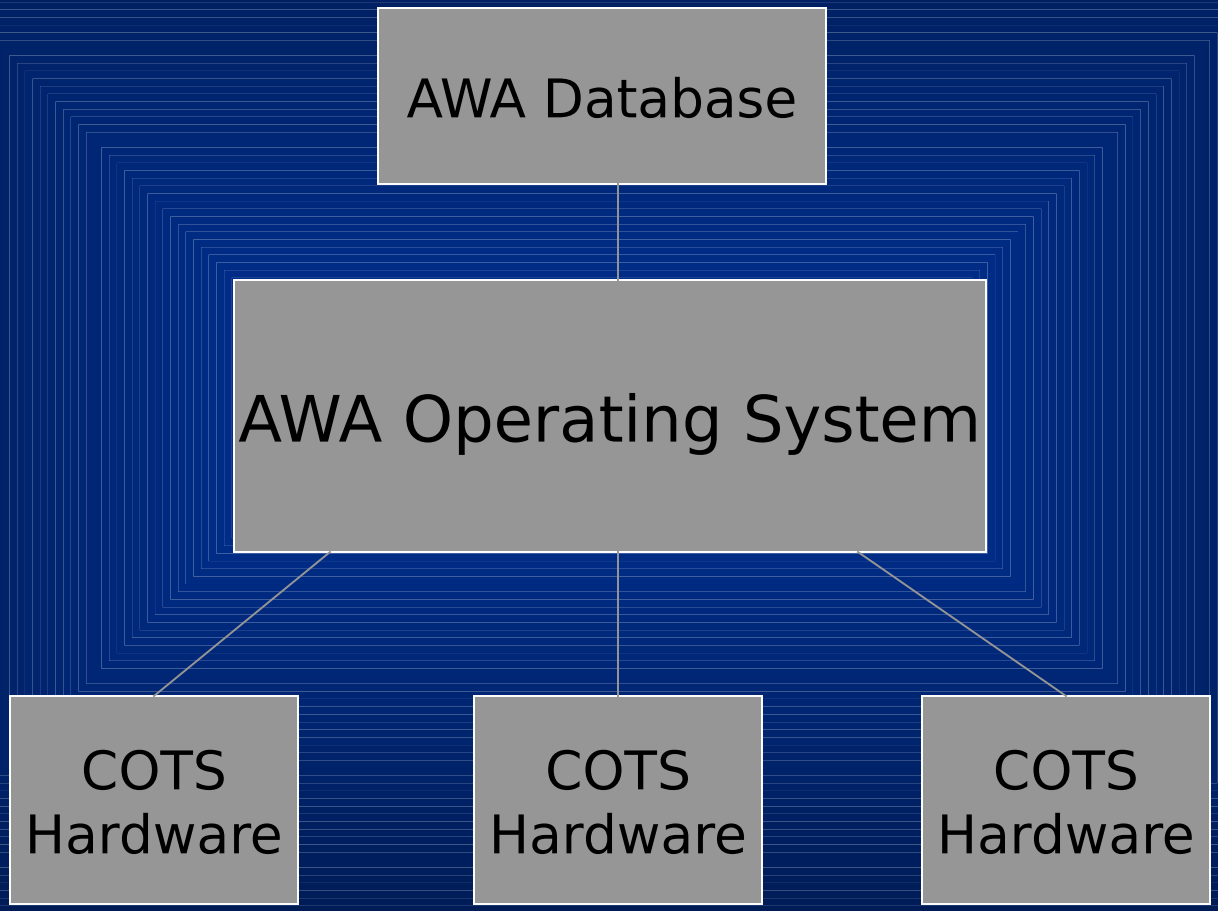
NAVAIR Addressing the Challenges

- Process improvements being implemented by NAVAIR to change the current maintenance culture as it relates to wiring
  - Maintenance Manual improvements (505 Manual)
  - Work Unit Code (WUC) and Malfunction Code (MAL codes) improvements
  - Training Improvements for the Technicians
  - AWA System Deployment

AWA System Implementation

- Hardware
  - Existing Commercial Off-the-Shelf Technology
    - Electrical Analyzer Systems for Fault Detection
    - Standing Wave Reflectometry for Fault location and waveform analysis
- Software
  - Customized package of programs designed to interface with COTS Hardware, improve wiring maintenance and insure consistent collection of wiring fault and measurement data

Basic AWA System Design



ECLYPSE

Initial System Hardware

RTS 501 Electrical Analyzer System

- USES DIRECT CURRENT VOLTAGES AND CURRENTS
  - MULTIPLE TEST PROTOCOL PER WIRE PATH
  - NON-DESTRUCTIVE
- BASIC CHECKS FAST/AUTO
  - OPENS (ISOLATION)
  - SHORTS (CONTINUITY)
  - 4-WIRE KELVIN
  - INSULATION TESTS
- CONTROL
- LOADING
- PROCEDURE/MENU DRIVEN

DETERMINE WHICH PATH IS BAD

ECLYPSE

Initial System Hardware

ESP Standing Wave Reflectometer

- USES NASA PATENTED STANDING WAVE REFLECTOMETRY
- MULTIPLE FREQUENCY TEST PROTOCOL PER WIRE PATH
  - NON-DESTRUCTIVE
- BASIC CHECK IS FAST/AUTO
  - OPENS (ISOLATION)
  - SHORTS (CONTINUITY)
  - DISTANCE IN FT/INCHES OR METERS/CM OR ALL INCHES
  - SOME WAVEFORM ANALYSIS CAPABILITY
- PROCEDURE/MENU DRIVEN

DETERMINE DISTANCE TO FAILURE ALONG PATH

ECLYPSE

System Software

- User friendly operator interfaces
  - Common windows environment
  - Presentation designed for an 18 year old age group
- Automated AWA Test Program Set development utilities to insure consistent protocols and results capture
- Open system architecture to allow utilization of other measurement Technologies
- Utilities to interface with existing Navy maintenance databases
  - NALCOMIS - Maintenance Database
  - AWIS - Electrical Component and Tool information
  - MRPII - Depot Resource Planning
- Development of an Aircraft wire configuration validation tool (Mapping Automation)

ECLYPSE

Final Thoughts

- Maintenance needs to move from a reactive to proactive posture relative to wiring
- Wiring needs to be treated as an aircraft system versus a “fit and forget” commodity

Conclusion

- The NAVAIR initiative coupled with the AWA system deployment is the first step in providing the means to meet these objectives

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